REQUIREMENT UNDER 37 C.F.R. 1.121

As required under 37 C.F.R.1.121, and pursuant to the present Amendment, a clean set of Claims is set forth below.

102. A laser scanning system comprising;

a housing having a first portion and a second portion, said first portion having a bottom window, and said second portion having a side window; and

a plurality of laser scanning stations, each comprising a light beam source and corresponding groups of light bending mirrors disposed within said housing, that cooperate with a plurality of light directing elements to produce laser scanning planes projected within a 3-D scanning volume disposed above said bottom window and adjacent said side window;

wherein a first set of laser scanning stations, disposed within said first portion of said housing, produce laser scanning planes passing through said bottom window;

wherein said first portion of said housing has a depth of less than 5 inches.

103. The laser scanning system of claim 102, wherein depth of said first portion is less than 3.5 inches.

104. The laser scanning system of claim 102, wherein a second set of laser scanning stations produce laser scanning planes passing through said side window.

105. The laser scanning system of claim 104, wherein said second portion houses groups of light bending mirrors for said second set of light scanning stations.

106. The laser scanning system of claim 102, wherein volume of said housing is less than 2000 cubic inches.

107. The laser scanning system of claim 102, wherein volume of said housing is less than 1650 cubic inches.

108. The laser scanning system of claim 102, wherein said 3-D scanning volume is greater than 400 cubic inches.

109. The laser scanning system of claim 102, wherein resolution of a bar code symbol that the laser scanning planes can resolve is on the order of 0.006 inches wide.

110. The laser scanning system of claim 102, wherein said laser scanning planes are quasi-orthogonal.

111. The laser scanning system of claim 102, wherein said plurality of light directing elements comprise a plurality of multi-faceted volume holographic elements.

112. The laser scanning system of claim 111, said plurality of multi-faceted volume holographic elements are supported by a scanning disc.

113. The laser scanning system of claim 102, wherein some groups of light bending mirrors cooperate with light directly elements that have high elevation angle characteristics, and other groups of light bending mirrors cooperate with light directly elements that having low elevation angle characteristics.

114. The laser scanning system of claim 102, wherein some groups of light bending mirrors cooperate with light directing elements that have left skew angle characteristics, and other groups of light bending mirrors cooperate with light directing elements that have right skew angle characteristics.

115. The laser scanning system of claim 102, wherein said bottom window has a substantially horizontal orientation and said side window has a substantially vertical orientation.

116. The laser scanning system of claim 102, wherein said plurality of laser scanning stations comprise four laser scanning stations.

117. The laser scanning system of claim 102, wherein some of said light bending mirrors having a different number of vertices than other light bending mirrors.

118. The laser scanning system of claim 102, wherein geometry, placement and orientation of said light bending mirrors are optimized to satisfy physical constraints with respect to said housing.

119. The laser scanning system of claim 102, wherein each laser scanning station includes light collection optical elements comprising a parabolic mirror and a photodetector.

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120. The laser scanning system of claim 119, wherein said photodetector is substantially disposed above incidence of light beams onto said light directing elements.

121. The laser scanning system of claim 102, wherein said bottom window has a substantially horizontal orientation and said side window has a substantially vertical orientation, and wherein said second set of laser scanning stations comprise a single laser scanning station that produces laser scanning planes passing through said side window.

122. The laser scanning system of claim 102, wherein said bottom and side windows include a spectral filtering subsystem that transmits a narrow band of spectral components including said laser scanning planes.

123. The laser scanning system of claim 102, wherein said light beam source for a given laser scanning station includes a visible laser diode, at least one collimating lens and a diffractive optical element producing S polarized light.

124. The laser scanning system of claim 123, wherein said collimating lens and diffractive optical element substantially eliminate astigmatic characteristics of light produced by the visible laser diode.

125. The laser scanning system of claim 102, further comprising light collection optical elements coupled to signal processing circuitry that has multiple decoding channels.

126. The laser scanning system of claim 125, further comprising a mechanism for linking, in each decoding channel, a particular optical path to a given scan data signal.

127. The laser scanning system of claim 126, further comprising a mechanism for analyzing scan data signal fragments over multiple decoding channels to identify bar code symbols therein.

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128. The laser scanning system of claim 102, wherein said first portion of the housing is disposed under a counter in a point of sale application.

129. The laser scanning system of claim 63, wherein a given laser scanning station produces scan lines that pass through said second window, said given laser scanning station comprising a collimating lens that cooperates with said plurality of holographic optical elements to increase focal distance of scan lines passing through said second window, thereby allowing said plurality of holographic optical elements to be used in producing scan lines that pass through both first and second windows.

130. The laser scanning system of claim 71, wherein said holographic optical elements are integrated in a rotating disc, and wherein said photodetector is mounted directly above the edge of the rotating disc.

131. The laser scanning system of claim 71, wherein said holographic optical elements are integrated in a rotating disc, and wherein said photodetector is mounted outside the outer periphery of the rotating disc.

132. The laser scanning system of claim 59, wherein at least one member of said first group G_1 of holographic optical elements have symmetrical left skew angle characteristics with respect to the right skew angle characteristics of at least one corresponding member of said second group G_2 of holographic optical elements.

133. The laser scanning system of claim 59, comprising multiple holographic optical elements which simultaneously focus multiple scanning beams to overlapping regions in a 3-D scanning volume at varying focal distances (preferably, less than 2 inches or less difference in focal distance), which minimizes the effects of paper noise.

134. The laser scanning system of claim 71, wherein said photodetector is disposed behind a given light bending mirror.

135. The laser scanning system of claim 134, wherein said given light bending mirror has a passageway that allows light collected by a corresponding parabolic mirror to reach said photodetector.

136. The laser scanning system of claim 59, wherein said light beam source for a given laser scanning station is deactivated (e.g., turned off) when the scan line produced therefrom is no longer passing through the first window or second window.

137. The laser scanning system of claim 59, wherein said holographic optical elements are integrated in a rotating disc, and wherein a light blocking element is disposed between said rotating disc and said first window, said light blocking element blocking zero-order beams produced from the rotating disc from passing through the first window, and said light blocking element blocking ambient light passing through the first window from reaching light collecting optical elements.

138. The laser scanning system of claim 85, wherein a given laser scanning station produces scan lines that pass through said side window, said given laser scanning station comprising a collimating lens that cooperates with said plurality of holographic optical elements to increase

focal distance of scan lines passing through said side window, thereby allowing said plurality of holographic optical elements to be used in producing scan lines that pass through both bottom and side windows.

139. The laser scanning system of claim 92, wherein said holographic optical elements are integrated in a scanning disc, and wherein said photodetector is mounted directly above the edge of the scanning disc.

140. The laser scanning system of claim 92, wherein said holographic optical elements are integrated in a scanning disc, and wherein said photodetector is mounted outside the outer periphery of the scanning disc.

141. The laser scanning system of claim 89, wherein at least one holographic optical element has a symmetrical left skew angle characteristic with respect to the right skew angle characteristic of at least one other holographic optical element.

142. The laser scanning system of claim 85, comprising multiple holographic optical elements which simultaneously focus multiple scanning beams to overlapping regions in a 3-D scanning volume at varying focal distances (preferably, less than 2 inches or less difference in focal distance), which minimizes the effects of paper noise.

143. The laser scanning system of claim 86, wherein each laser scanning station includes light collection optical elements comprising a parabolic mirror and a photodetector, wherein said photodetector is disposed behind a given light bending mirror.

144. The laser scanning system of claim 143, wherein said given light bending mirror has a passageway that allows light collected by a corresponding parabolic mirror to reach said photodetector.

145. The laser scanning system of claim 86, wherein said light beam source for a given laser scanning station is deactivated (e.g., turned off) when the scan line produced therefrom is no longer passing through the bottom window or side window.

146. The laser scanning system of claim 85, wherein said holographic optical elements are integrated in a rotating disc, and wherein a light blocking element is disposed between said rotating disc and said bottom window, said light blocking element blocking zero-order beams produced from the rotating disc from passing through the bottom window, and said light blocking element blocking ambient light passing through the bottom window from reaching light collecting optical elements.

147. The laser scanning system of claim 111, wherein a given laser scanning station produces scan lines that pass through said side window, said given laser scanning station comprising a collimating lens that cooperates with said plurality of multi-faceted volume holographic elements to increase focal distance of scan lines passing through said side window, thereby allowing said plurality of multi-faceted volume holographic elements to be used in producing scan lines that pass through both bottom and side windows.

148. The laser scanning system of claim 119, wherein said multi-faceted volume holographic elements are integrated in a scanning disc, and wherein said photodetector is mounted directly above the edge of the scanning disc.

149. The laser scanning system of claim 119, wherein said multi-faceted volume holographic elements are integrated in a scanning disc, and wherein said photodetector is mounted outside the outer periphery of the scanning disc.

150. The laser scanning system of claim 114, wherein at least one light directing element has a symmetrical left skew angle characteristic with respect to the right skew angle characteristic of at least one other light directing element.

151. The laser scanning system of claim 102, comprising multiple light directing elements which simultaneously focus multiple scanning beams to overlapping regions in a 3-D scanning volume at varying focal distances (preferably, less than 2 inches or less difference in focal distance), which minimizes the effects of paper noise.

152. The laser scanning system of claim 119, wherein said photodetector is disposed behind a given light bending mirror.

153. The laser scanning system of claim 152, wherein said given light bending mirror has a passageway that allows light collected by a corresponding parabolic mirror to reach said photodetector.

154. The laser scanning system of claim 102, wherein a light beam source for a given laser scanning station is deactivated (e.g., turned off) when the scan line produced therefrom is no longer passing through the bottom window or side window.

155. The laser scanning system of claim 111, wherein said multi-faceted volume holographic elements are integrated in a scanning disc, and wherein a light blocking element is disposed between said scanning disc and said bottom window, said light blocking element blocking zero-order beams produced from the scanning disc from passing through the bottom window, and said light blocking element blocking ambient light passing through the bottom window from reaching light collecting optical elements.

WHAT IS CLAIMED IS:

102. A laser scanning system comprising:

a housing having a first portion and a second portion, said first portion having a bottom window, and said second portion having a side window; and

a plurality of laser scanning stations, each comprising a light beam source and corresponding groups of light bending mirrors disposed within said housing, that cooperate with a plurality of light directing elements to produce laser scanning planes projected within a 3-D scanning volume disposed above said bottom window and adjacent said side window;

wherein a first set of laser scanning stations, disposed within said first portion of said housing, produce laser scanning planes passing through said bottom window;

wherein said first portion of said housing has a depth of less than 5 inches.

103. The laser scanning system of claim 102, wherein depth of said first portion is less than 3.5 inches.

104. The laser scanning system of claim 102, wherein a second set of laser scanning stations produce laser scanning planes passing through said side window.

105. The laser scanning system of claim 104, wherein said second portion houses groups of light bending mirrors for said second set of light scanning stations.

106. The laser scanning system of claim 102, wherein volume of said housing is less than 2000 cubic inches.

107. The laser scanning system of claim 102, wherein volume of said housing is less than 1650 cubic inches.

108. The laser scanning system of claim 102, wherein said 3-D scanning volume is greater than 400 cubic inches.

109. The laser scanning system of claim 102, wherein resolution of a bar code symbol that the laser scanning planes can resolve is on the order of 0.006 inches wide.

110. The laser scanning system of claim 102, wherein said laser scanning planes are quasi-orthogonal.

111. The laser scanning system of claim 102, wherein said plurality of light directing elements comprise a plurality of multi-faceted volume holographic elements.

112. The laser scanning system of claim 111, said plurality of multi-faceted volume holographic elements are supported by a scanning disc.

113. The laser scanning system of claim 102, wherein some groups of light bending mirrors cooperate with light directly elements that have high elevation angle characteristics, and other groups of light bending mirrors cooperate with light directly elements that having low elevation angle characteristics.

114. The laser scanning system of claim 102, wherein some groups of light bending mirrors cooperate with light directing elements that have left skew angle characteristics, and other groups of light bending mirrors cooperate with light directing elements that have right skew angle characteristics.

115. The laser scanning system of claim 102, wherein said bottom window has a substantially horizontal orientation and said side window has a substantially vertical orientation.

116. The laser scanning system of claim 102, wherein said plurality of laser scanning stations comprise four laser scanning stations.

117. The laser scanning system of claim 102, wherein some of said light bending mirrors having a different number of vertices than other light bending mirrors.

118. The laser scanning system of claim 102, wherein geometry, placement and orientation of said light bending mirrors are optimized to satisfy physical constraints with respect to said housing.

119. The laser scanning system of claim 102, wherein each laser scanning station includes light collection optical elements comprising a parabolic mirror and a photodetector.

120. The laser scanning system of claim 119, wherein said photodetector is substantially disposed above incidence of light beams onto said light directing elements.

121. The laser scanning system of claim 102, wherein said bottom window has a substantially horizontal orientation and said side window has a substantially vertical orientation, and wherein said second set of laser scanning stations comprise a single laser scanning station that produces laser scanning planes passing through said side window.

122. The laser scanning system of claim 102, wherein said bottom and side windows include a spectral filtering subsystem that transmits a narrow band of spectral components including said laser scanning planes.

123. The laser scanning system of claim 102, wherein said light beam source for a given laser scanning station includes a visible laser diode, at least one collimating lens and a diffractive optical element producing S polarized light.

124. The laser scanning system of claim 123, wherein said collimating lens and diffractive optical element substantially eliminate astigmatic characteristics of light produced by the visible laser diode.

125. The laser scanning system of claim 102, further comprising light collection optical elements coupled to signal processing circuitry that has multiple decoding channels.

126. The laser scanning system of claim 125, further comprising a mechanism for linking, in each decoding channel, a particular optical path to a given scan data signal.

127. The laser scanning system of claim 126, further comprising a mechanism for analyzing scan data signal fragments over multiple decoding channels to identify bar code symbols therein.

128. The laser scanning system of claim 102, wherein said first portion of the housing is disposed under a counter in a point of sale application.

129. The laser scanning system of claim 63, wherein a given laser scanning station produces scan lines that pass through said second window, said given laser scanning station comprising a collimating lens that cooperates with said plurality of holographic optical elements to increase focal distance of scan lines passing through said second window, thereby allowing said plurality of holographic optical elements to be used in producing scan lines that pass through both first and second windows.

130. The laser scanning system of claim 71, wherein said holographic optical elements are integrated in a rotating disc, and wherein said photodetector is mounted directly above the edge of the rotating disc.

131. The laser scanning system of claim 71, wherein said holographic optical elements are integrated in a rotating disc, and wherein said photodetector is mounted outside the outer periphery of the rotating disc.

132. The laser scanning system of claim 59, wherein at least one member of said first group G_1 of holographic optical elements have symmetrical left skew angle characteristics with respect to the right skew angle characteristics of at least one corresponding member of said second group G_2 of holographic optical elements.

133. The laser scanning system of claim 59, comprising multiple holographic optical elements which simultaneously focus multiple scanning beams to overlapping regions in a 3-D scanning volume at varying focal distances (preferably, less than 2 inches or less difference in focal distance), which minimizes the effects of paper noise.

134. The laser scanning system of claim 71, wherein said photodetector is disposed behind a given light bending mirror.

135. The laser scanning system of claim 134, wherein said given light bending mirror has a passageway that allows light collected by a corresponding parabolic mirror to reach said photodetector.

136. The laser scanning system of claim 59, wherein said light beam source for a given laser scanning station is deactivated (e.g., turned off) when the scan line produced therefrom is no longer passing through the first window or second window.

137. The laser scanning system of claim 59, wherein said holographic optical elements are integrated in a rotating disc, and wherein a light blocking element is disposed between said rotating disc and said first window, said light blocking element blocking zero-order beams produced from the rotating disc from passing through the first window, and said light blocking element blocking ambient light passing through the first window from reaching light collecting optical elements.

138. The laser scanning system of claim 85, wherein a given laser scanning station produces scan lines that pass through said side window, said given laser scanning station comprising a collimating lens that cooperates with said plurality of holographic optical elements to increase focal distance of scan lines passing through said side window, thereby allowing said plurality of holographic optical elements to be used in producing scan lines that pass through both bottom and side windows.

139. The laser scanning system of claim 92, wherein said holographic optical elements are integrated in a scanning disc, and wherein said photodetector is mounted directly above the edge of the scanning disc.

140. The laser scanning system of claim 92, wherein said holographic optical elements are integrated in a scanning disc, and wherein said photodetector is mounted outside the outer periphery of the scanning disc.

141. The laser scanning system of claim 89, wherein at least one holographic optical element has a symmetrical left skew angle characteristic with respect to the right skew angle characteristic of at least one other holographic optical element.

142. The laser scanning system of claim 85, comprising multiple holographic optical elements which simultaneously focus multiple scanning beams to overlapping regions in a 3-D scanning volume at varying focal distances (preferably, less than 2 inches or less difference in focal distance), which minimizes the effects of paper noise.

143. The laser scanning system of claim 86, wherein each laser scanning station includes light collection optical elements comprising a parabolic mirror and a photodetector, wherein said photodetector is disposed behind a given light bending mirror.

144. The laser scanning system of claim 143, wherein said given light bending mirror has a passageway that allows light collected by a corresponding parabolic mirror to reach said photodetector.

145. The laser scanning system of claim 86, wherein said light beam source for a given laser scanning station is deactivated (e.g., turned off) when the scan line produced therefrom is no longer passing through the bottom window or side window.

146. The laser scanning system of claim 85, wherein said holographic optical elements are integrated in a rotating disc, and wherein a light blocking element is disposed between said

rotating disc and said bottom window, said light blocking element blocking zero-order beams produced from the rotating disc from passing through the bottom window, and said light blocking element blocking ambient light passing through the bottom window from reaching light collecting optical elements.

147. The laser scanning system of claim 111, wherein a given laser scanning station produces scan lines that pass through said side window, said given laser scanning station comprising a collimating lens that cooperates with said plurality of multi-faceted volume holographic elements to increase focal distance of scan lines passing through said side window, thereby allowing said plurality of multi-faceted volume holographic elements to be used in producing scan lines that pass through both bottom and side windows.

148. The laser scanning system of claim 119, wherein said multi-faceted volume holographic elements are integrated in a scanning disc, and wherein said photodetector is mounted directly above the edge of the scanning disc.

149. The laser scanning system of claim 119, wherein said multi-faceted volume holographic elements are integrated in a scanning disc, and wherein said photodetector is mounted outside the outer periphery of the scanning disc.

150. The laser scanning system of claim 114, wherein at least one light directing element has a symmetrical left skew angle characteristic with respect to the right skew angle characteristic of at least one other light directing element.

151. The laser scanning system of claim 102, comprising multiple light directing elements which simultaneously focus multiple scanning beams to overlapping regions in a 3-D scanning volume at varying focal distances (preferably, less than 2 inches or less difference in focal distance), which minimizes the effects of paper noise.

152. The laser scanning system of claim 119, wherein said photodetector is disposed behind a given light bending mirror.

153. The laser scanning system of claim 152, wherein said given light bending mirror has a passageway that allows light collected by a corresponding parabolic mirror to reach said photodetector.

154. The laser scanning system of claim 102, wherein a light beam source for a given laser scanning station is deactivated (e.g., turned off) when the scan line produced therefrom is no longer passing through the bottom window or side window.

155. The laser scanning system of claim 111, wherein said multi-faceted volume holographic elements are integrated in a scanning disc, and wherein a light blocking element is disposed between said scanning disc and said bottom window, said light blocking element blocking zero-order beams produced from the scanning disc from passing through the bottom window, and said light blocking element blocking ambient light passing through the bottom window from reaching light collecting optical elements.